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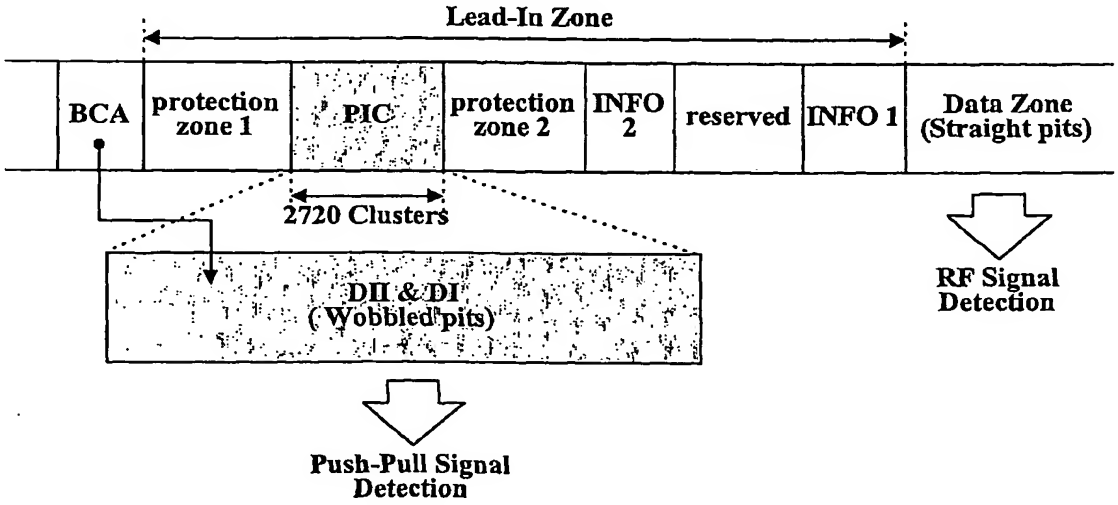
(54) Title: RECORDING MEDIUM WITH COPY PROTECTION INFORMATION FORMED IN INTERMITTENT OR ALTERNATE WOBBLED PITS AND APPARATUS AND METHODS FOR FORMING, RECORDING, AND REPRODUCING THE RECORDING MEDIUM



(57) Abstract: A recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains copy protection information encoded in intermittent or alternate wobbled pits, and to methods and apparatuses for forming, recording, and reproducing data on the recording medium.

WO 2004/066286 A1

DESCRIPTION

RECORDING MEDIUM WITH COPY PROTECTION INFORMATION FORMED IN INTERMITTENT OR ALTERNATE WOBBLED PITS AND APPARATUS AND METHODS FOR FORMING, RECORDING, AND REPRODUCING THE RECORDING MEDIUM

1. TECHNICAL FIELD

The present invention relates to a recording medium such as BD-ROM (Blu-ray Disc ROM) which has data written in intermittent or alternate wobbled (or zigzag) pits and an apparatus and methods for forming, recording, and reproducing the recording medium.

2. BACKGROUND ART

Recently, the standardization of Blu-ray Disc Rewritable (BD-RE), which is a new high-density rewritable optical disk capable of recording large capacity, high-quality video and audio data, is in progress. BD-RE related products are expected to be available on the market in the near future.

FIG. 1A depicts the structure of a BD-RE, wherein a clamping area, a burst cutting area (BCA), a transition area, a lead-in area, a data area, and lead-out area are disposed in order as shown.

As illustrated in FIG. 1B, the BCA is located in the innermost circumferential area of the BD-RE that is accessed first when the disk is loaded into a reproducing apparatus and may contain an information for the disc, such as serial number and other optional information pre-recorded by disc manufacturer.

The lead-in area may comprise several pre-assigned areas such as a first guard (Guard 1) area, a permanent information

& control data (PIC) area, a second guard (Guard 2) area, a second information (Info 2) area, and an optimum power calibration (OPC) area. The Guard 1 area and the PIC area are pre-recorded areas in which some initial data is pre-recorded, whereas the other areas of the lead-in area, the data area, and the lead-out areas are all rewritable areas.

In the PIC area, important permanent disc information is encoded in a wobbled groove by high frequency modulation (HFM).

HFM Grooves are modulated in the radial direction with a rather high bandwidth signal, to create a data channel for replicated information with sufficient capacity and data rate.

As depicted in FIG. 2, the wobble-shaped data encoding is performed by bi-phase modulation. In this modulation method a bit with value 0 is represented by a transition at the start of the bit cell and a bit with value 1 is represented by a transition at the start and in the middle of the bit cell. The modulated bits are recorded on the disc by a deviation of the groove from its average centerline as indicated in the FIG.2. The length of each bit cell shall be 36T, where T corresponds to the length of a channel bit in the Rewritable data areas.

Also, a read-only Blu-ray Disk (BD-ROM) is also under development along with the BD-RE. A BD-ROM may include an inner area, a clamping area, a transition area, an information area, and a rim area, as shown in FIG. 3.

The information area may further comprise a BCA, a lead-in zone, a data zone, a lead-out zone, and an outer zone. As in BD-RE, the BCA may contain disc important information (DII), such as a disc serial number and copy protection information (CPI). If a BD-ROM is copy protected, the DII may be required to decrypt the main data contained on the BD-ROM.

The disc information in the PIC zone may be recorded as

straight pits in the same way as main data such as audio/video (A/V) streams are recorded in the data zone. The disc information may be 17PP-modulated data written in the form of an error correction code (ECC) block of size 64 KB, for example.

In this case, however, it takes some demodulation time to retrieve the disc information from the BD-ROM because the disc information may be demodulated by an RF signal detection method.

As described above, the disc information contained in the PIC area of a BD-RE may be encoded in a wobbled groove by HFM. If the disc information is recorded in the PIC zone of a BD-ROM as straight pits, an optical disk reproducing apparatus should be able to apply different detecting schemes to obtain the disc information depending on the disk type (BD-RE or BD-ROM). Unless the correct scheme is chosen, the optical disk reproducing apparatus will fail to detect the disc information. For example, if a method for detecting HFM-modulated disc information encoded in a wobbled groove of a BD-RE is applied to a BD-ROM, the optical disk reproducing apparatus will not be able to retrieve the disc information which is recorded in the PIC zone as straight pits.

In addition, if the disc important information (DII) contained in the BCA cannot be retrieved due to a read error, it is impossible to retrieve the data recorded on the disk. For example, if an error occurs while the copy protection information (CPI) is retrieved from the BCA, it may be impossible to reproduce the main data recorded in the data zone because the data cannot be decrypted.

Also, because the copy protection information (CPI) recorded on PIC area of the disk includes an important data, e.g., key data to decrypt an encrypted main data recorded on the data zone, it should not be detected easily by any illegal

device and copied to other recording media to protect the encrypted contents recorded on the disk. It should be only detected by a predetermined detection method in a legally permitted device to ensure a robustness.

3. DISCLOSURE OF INVENTION

In exemplary embodiments, the present invention is directed to a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, capable of rapidly detecting disc information required for reproducing the contents recorded thereon, and to methods and apparatuses for forming, recording, and reproducing data on the recording medium.

In exemplary embodiments, the present invention is directed to a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, capable of reproducing main data even if there is a failure in reading disc important information from one or more location on the recording medium, and to methods and apparatuses for forming, recording, and reproducing data on the recording medium.

In exemplary embodiments, the present invention is directed to a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, including decryption information for decrypting contents recorded on the recording medium in such a way that the decryption information is not copied to other recording media and/or other types of recording media, and to methods and apparatuses for forming, recording, and reproducing data on the recording medium.

In exemplary embodiments, the present invention is directed to a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains disc information encoded in wobbled pits in some sections of the recording medium, such as the PIC zone, and to methods and

apparatuses for forming, recording, and reproducing data on the recording medium.

In exemplary embodiments, the present invention is directed to a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains disc important information in more than one location, for example, in the BCA and in another area other than the BCA, and to methods and apparatuses for forming, recording, and reproducing data on the recording medium.

In exemplary embodiments, the present invention is directed to a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains copy protection information encoded in wobbled pits, and to methods and apparatuses for forming, recording, and reproducing data on the recording medium.

In exemplary embodiments, the present invention is directed to a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains copy protection information encoded in intermittently formed arrays of wobbled pits in a distributed manner, and to methods and apparatuses for forming, recording, and reproducing data on the recording medium.

In exemplary embodiments, the present invention is directed to a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains pits formed along tracks, with data recorded therein, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits, wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits shifted from the track center, and to methods and apparatuses for forming, recording, and

reproducing data on the recording medium.

In exemplary embodiments, the present invention is directed to method for forming a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains the steps of forming pits formed along tracks, with data recorded therein, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits, wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits shifted from the track center.

In exemplary embodiments, the present invention is directed to method for reproducing a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains the steps of utilizing data recorded in pits formed along tracks, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits, wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits shifted from the track center.

In exemplary embodiments, the present invention is directed to method for recording a recording medium, such as a high-density and/or read-only recording medium, such as BD-ROM, which contains the steps of recording data in pits formed along tracks, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits , wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits

shifted from the track center.

4. BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate exemplary embodiments of the invention, and together with the description, serve to explain the principles of the present invention.

In the drawings:

FIGS. 1A and 1B illustrate the structure of a conventional BD-RE;

FIG. 2 illustrates a high-frequency modulated (HFM) groove formed in the PIC area of a BD-RE;

FIG. 3 illustrates areas assigned to a BD-ROM;

FIGS. 4A-4F illustrate several formats of data recorded in the PIC zone of a BD-ROM in accordance with exemplary embodiments of the invention;

FIG. 5 illustrates an example in which the copy protection information is encoded in intermittently formed arrays of wobbled pits in an exemplary embodiment of the present invention;

FIG. 6 illustrates the data structure of a physical cluster of a BD-ROM in an exemplary embodiment of the present invention;

FIG. 7 illustrates information encoded in wobbled pits and a circuit for detecting the information in an exemplary embodiment of the present invention;

FIG. 8 illustrates information encoded in straight pits and a circuit for detecting the information in an exemplary embodiment of the present invention;

FIG. 9 illustrates disc information fields recorded on a BD-ROM in an exemplary embodiment of the present invention;

FIG. 10 illustrates disc type information recorded in the

BCA in accordance with an exemplary embodiment of the invention; and

FIG. 11 illustrates a schematic diagram of an optical disk reproducing apparatus capable of reproducing a BD-ROM in accordance with an exemplary embodiment of the present invention.

5. MODES FOR CARRYING OUT THE INVENTION

In order that the invention may be fully understood, exemplary embodiments thereof will now be described with reference to the accompanying drawings.

The BD-ROM in accordance with exemplary embodiments of the invention may include an inner area, a clamping area, a transition area, an information area, and a rim area, as described above with reference to FIG. 3. As illustrated in FIG. 4A, the DII, such as a disc serial number and copy protection information recorded in the BCA, is copied to the PIC zone contained in the information area at least once. The copy protection information can be a key value required to decrypt the encrypted main data of A/V streams recorded in the data zone.

The copy protection information may not be recorded in the BCA and be only recorded in the PIC zone, which is illustrated in FIG. 4B. The copy protection information may also be called a 'ROM mark' and may contain an additional flag (CPI flag) indicating whether the copy protection information is recorded.

As depicted in FIG. 4C, the information contained in the PIC may be recorded partly as wobbled pits (or zigzag pits) and partly as straight pits. The main data may be recorded in the data zone as straight pits.

In an exemplary embodiment, the PIC zone may contain 2,720 clusters of data. The first cluster may contain disc

information recorded as wobbled pits by bi-phase modulation. The other clusters may contain 17PP modulated disc information and copy protection information having ECC blocks of size 64 KB and recorded as straight pits, for example the disc information recorded as wobbled pits may be detected by a push-pull signal detecting method and the disc information and copy protection information recorded as straight pits may be detected by an RF signal detecting method. The push-pull signal typically has lower frequency components than the RF signal.

In an exemplary embodiment, the DII additionally copied to the PIC zone can be encoded in wobbled pits to prevent it from being detected by the RF signal detecting method.

FIGS. 4D, 4E, and 4F illustrate several different exemplary data formats. In FIG. 4D, the DII is encoded in wobbled pits and disc information is recorded as straight pits. In FIG. 4E, the DII and a part of the disc information are encoded in wobbled pits. In FIG. 4F, both of the DII and disc information are encoded in wobbled pits.

The copy protection information, in one example, the ROM mark, may be encoded in intermittently formed wobbled pits to prevent it from being easily detected by common detecting methods, while the data recorded on the data zone is formed of straight pit.

FIG. 5 illustrates an exemplary embodiment of the present invention, where the copy protection information is encoded in intermittently formed arrays of wobbled pits.

As shown in FIG.5, it is preferable that intermittent wobble structure is recorded on the area instead of a continuous wobble pit structure in order to ensure the secret or the robustness, such that it prevents a copy protection information from being easily detected by the common detecting method.

In FIG. 5, arrays of straight pits (An) and arrays of wobbled pits (Bn) are formed alternately and the arrays of straight pits are longer length than the arrays of wobbled pits to have a different duration. Consequently, the wobbled pits in which the copy protection information is encoded are considered noise signals by common detecting methods.

All of the arrays of straight pits can be made to have the same length and all of the arrays of wobbled pits can be made to have the same length. If the arrays of pits are of different length, that is, if An≠Am (n≠m) and Bn≠Bm (n≠m), the occurrence of the arrays of wobbled pits is not periodic. This can enhance the security of the copy protection information in that the probability that special information is encoded in wobbled pits becomes lower.

There are various other modulation methods that can be employed to encode the copy protection information in wobbled pits. Analog modulation methods include amplitude modulation (AM), frequency modulation (FM) and digital modulation methods include pulse code modulation (PCM), minimum shift keying (MSK), and binary phase shift keying (BPSK).

Although the same modulation technique can be applied to all arrays of wobbled pits, arrays of wobbled pits can be encoded by different modulation techniques to enhance the security of the copy protection information. In FIG. 5, for example, the first wobbled-pit array, B1, may be encoded by AM and the second wobbled-pit array, B2, may be encoded by FM, etc.

To decrease possible data read errors, in an exemplary embodiment the same data be repeatedly encoded in arrays of wobbled pits.

And said region of wobble pit and said region of no wobble pit are combined or a plurality of regions are combined and then a bit for copy protection can be detected. For

example, recording region of wobble pit corresponding to the data bit is recorded dispersedly to several regions, and the wobble pits is formed such that the amplitude of wobble are small, and then the bit can be detected by detecting a pushpull signal of low level and integrating the signal.

In an exemplary embodiment, the copy protection information has a size of no more than 128 bits, but if header information and redundant data for ECC are appended, the size can increase up to 1 KB.

As shown in FIG. 6, a physical cluster of the BD-ROM may have an exemplary size of 64 KB and includes 16 address units. Each address unit may further include 31 data frames. As a result, if the first data frame (Data Frame #0) of each address unit is encoded in wobbled pits to record a byte of the copy protection information, a physical cluster can store up to 16 bytes.

Hence, the copy protection information of size 1 KB can be contained in 64 clusters. If an exemplary PIC zone may include 2,720 clusters, the PIC zone will have enough space to store the copy protection information at least one. Further, the copy protection information can be recorded in the PIC zone more than once to enhance reliability of the recorded data.

In other exemplary embodiments, it is also possible to form data frames other than the first data frame of each address unit as wobbled pits or more than two data frames of each address unit as wobbled pits to encode the copy protection information.

Instead of encoding the copy protection information in a fixed data frame within each address unit, the information can also be encoded in an arbitrary data frame within each address unit. In this exemplary embodiment, the occurrence of low-frequency signals created by the wobbled pits is not of

periodic nature and thus it can enhance the information security as described above.

The copy protection information can also be recorded as straight pits. In this exemplary embodiment, the copy protection information can be encrypted before being recorded and a key value to decrypt the encrypted copy protection information can be encoded in wobbled pits, thereby preventing illegal copying of the contents.

FIG. 7 illustrates the disc information encoded in wobbled pits by bi-phase modulation and a circuit for detecting the information, wherein an exemplary value of '0101' is encoded in bi-phase modulated form, e.g., bi- phase modulated HFM Groove, along with wobbled pits. In this example, a data bit is recorded as marks and spaces of length 36T including six 3T marks. Six pits representing '1' and six pits representing '0' are shifted from the track center in the opposite directions.

As shown in FIG. 7. the structure by bi-phase modulation is different from the structure illustrated in FIG.2. That is, the method of FIG.2 has a bit with value 0, which is represented by a transition at the start of the bit cell and a bit with value 1, which is represented by a transition at the start and in the middle of the bit cell. Otherwise, the method of FIG.7 has a bit with value 0, which is represented by a transition at the start of low and in the middle of high, and a bit with value 1, which is represented by the transition in the opposite direction. The combination of bits consists of data to detect information recorded as wobbled pit. The information can be copy protection information, i.e., key data to decrypt main data recorded on the data zone of the recording medium as shown in FIG.4A to 4F

That is, the wobbled pit data can be reproduced or detected only when the bi-phased modulation data modulated by

HFM is detected or reproduced normally. And also, reproduction or decryption of main data is possible only when the wobbled pit data for copy protection is reproduced or detected using the normally detected or reproduced bi-phase modulation data.

In meantime, if the information is encoded in pits, the occurrence of successive pits of the same length may not be allowed and thus pits of different length appear one after another. In this exemplary embodiment, the positions of data pits may also be shifted at intervals of 18 T to encode data in wobbled pits.

The laser beam reflected by the wobbled pits is converted into electric signals by photo detectors 13-16.

The electric signals may be amplified by a push-pull detecting circuit, wherein Ea+Eb and Ec+Ed are amplified separately by amplifiers 10 and 11 and then the difference signal ((Ea+Eb)-(Ec+Ed)) between the two amplified signals is generated by a differential amplifier 12. The data encoded in the wobbled pits is obtained by comparing the difference signal 501 with a threshold level.

Similarly, the DII and/or disc information (or other information) encoded in wobbled pits can be obtained by a push-pull circuit that is used to create the tracking error signal, with no additional error correction and demodulation processes.

If an error due to scratches or other disc deformities occurs when accessing the BCA of a BD-ROM, the DII can be retrieved from the PIC zone and data recorded on the disk can be reproduced using the retrieved information. As a result, the main data recorded in the data zone may be decrypted using a decryption key contained in the DII recorded in the PIC zone.

Since the data encoded in wobbled pits, for example, DII and/or disc information, is not obtained by demodulation, it is not copied when the contents of the BD-ROM is copied to

another rewritable medium and therefore the encrypted data copied to the rewritable medium cannot be decrypted, thereby preventing illegal copying of the BD-ROM contents.

The disc information and copy protection information encoded in straight pits as shown in FIGS. 4C-4E may be detected by the circuit depicted in FIG. 8.

The laser beam reflected by the straight pits is converted into electric signals by photo detectors 13-16 and the electric signals (Ea, Eb, Ec, and Ed) are added together with amplification by one or more summing amplifiers 20, 21, and 22. The RF signal, Ea + Eb + Ec + Ed, which is the output of the summing amplifier 22, is converted into a binary pulse train by an RF unit 23 and converted into digital data by a clock signal synchronized with the binary signal. The original disc information and copy protection information are obtained from the digital data by an ECC & demodulator 24.

The disc information and copy protection information encoded in straight pits can be read in the same way that the main data recorded in the data zone is read.

The disc information may include a disc information ID, a disc information format, a disc type ID, disc size/version, etc, as shown in FIG. 9. An exemplary 3-byte disc type ID indicative of the type of the optical disk can be recorded in the BCA as 2-bit data, as shown in FIG. 10.

For example, if the 2-bit data is 00b, the corresponding optical disk is a BD-RE. If the data is 01b, the corresponding optical disk is a one-time recordable BD-R. If the data is 10b, the corresponding optical disk is a BD-ROM.

The disc information size and a flag indicating whether it is the last disc information can be assigned to a reserved field of the disc information.

FIG. 11 illustrates a schematic diagram of a general optical disk reproducing apparatus including an optical pickup

30, a video disc play (VDP) system 31, and a D/A converter 32. Once an optical disk is loaded, the VDP system 31, which performs signal processing and servo control, detects the disk type information recorded in the BCA and performs appropriate servo initialization according to the detected disk type.

The VDP system 31 can detect the disc information encoded in wobbled pits, e.g., a key data to encrypt and/or decrypt the main data of data zone, in the PIC zone from the push-pull signal.

Where the disc information size and a flag indicating whether it is the last disc information are assigned to a reserved field, the disc information and copy protection information recorded in the PIC zone can be detected more accurately using the information in the reserved field.

In another exemplary embodiment, it is possible that a transition zone for separately detecting the disc information and the copy protection information is allocated to the PIC zone.

If the copy protection information is encrypted and encoded in straight pits, the VDP system 31 detects the decryption key encoded in wobbled pits in the PIC zone as described in FIG. 7, decrypts the copy protection information read from the straight pits, and stores the decrypted copy protection information. When the main data recorded in the data zone is reproduced, the main data is decrypted using the stored copy protection information.

The high-density, read-only, and/or optical disk and disc information recording method therefore in accordance with exemplary embodiments of the invention may repeatedly record important information required for the protection of the contents recorded on the disk and encode the information in wobbled pits, thereby enhancing data reliability and preventing illegal copying of the contents of the disk.

Although certain exemplary embodiments of the present invention have been disclosed, it is noted that the present invention may be embodied in other forms without departing from the spirit or essential characteristics thereof. The exemplary embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, and all changes that come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

CLAIMS

1. A recording medium including recorded data, comprising:

pits formed along tracks, with data recorded therein, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits, wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits shifted from the track center.

2. The recording medium according to claim 1, wherein the wobbled pits are in a lead-in zone of an information area of the recording medium.

3. The recording medium according to claim 2, wherein the wobble pits are in a permanent information & control (PIC) data area of the information area of the recording medium.

4. The recording medium according to claim 1, wherein the wobble pits are in a burst cutting area (BCA) of an information area of the recording medium, and the BCA includes disc type information.

5. The recording medium according to claim 1, wherein data is encoded in the deviation shape of said wobbled pits.

6. The recording medium according to claim 5, wherein said deviation shape has bi-phase modulated bit values.

7. The recording medium according to claim 1, wherein said data includes information about the recording medium including the type of the recording medium.

8. The recording medium according to claim 1, wherein said data includes decryption information for decrypting encrypted contents recorded on the recording medium.

9. The recording medium according to claim 1, wherein

said data further includes at least one of a serial number of the recording medium, disc information, and disc important information.

10. The recording medium according to claim 1, wherein said copy protection information is a copy protect flag.

11. The recording medium according to claim 9, wherein said disc information and said disc important information may be recorded in the wobbled pits.

12. The recording medium according to claim 11', wherein said wobbled pits are detected by push-pull signal detection.

13. The recording medium according to claim 9, wherein said disc information may be recorded in straight pits.

14. The recording medium according to claim 13, wherein said straight pits are detected by RF signal detection.

15. The recording medium according to claim 1, wherein said recorded data is recorded in straight pits and said straight pits are detected by RF signal detection.

16. The recording medium according to claim 3, wherein information about the recording medium including the type of the recording medium is recorded with modulation as straight pits positioned in said PIC zone, wherein the straight pits are not shifted from the track center.

17. The recording medium according to claim 3, wherein decryption information for decrypting encrypted data recorded on the recording medium is recorded with modulation as straight pits positioned in said PIC zone.

18. The recording medium according to claim 17, wherein decryption key information for decrypting said encrypted decryption information is encoded in the deviation shape of said pits shifted from the track center.

19. The recording medium according to claim 1, wherein arrays of said pits shifted from the track center are formed intermittently at more than two places.

20. The recording medium according to claim 19, wherein a length of an array of straight pits between arrays of said pits shifted from the track center is larger than a length of arrays of said pits shifted from the track center.

21. The recording medium according to claim 19, wherein each of the arrays of said pits shifted from the track center has a different length.

22. The recording medium according to claim 21, wherein each of the arrays of straight pits between arrays of said shifted pits has a different length.

23. A method of forming a recording medium, comprising:

forming pits formed along tracks, with data recorded therein, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits, wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits shifted from the track center.

24. A method of reproducing data from a recording medium, comprising:

utilizing data recorded in pits formed along tracks, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits, wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits shifted from the track center.

25. A method of recording data on a recording medium, comprising:

recording data in pits formed along tracks, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks

are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits , wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits shifted from the track center.

26. An apparatus for reproducing data from a recording medium, said apparatus utilizing pits formed along tracks, with data recorded therein, the data including copy protection information for encryption and/or decryption, wherein pits formed in some portions of the tracks are shifted from a track center to left and/or right to thereby form intermittent or alternate wobbled pits, wherein key information for encryption and/or decryption is encoded in a deviation shape of said pits shifted from the track center.

FIG. 1A

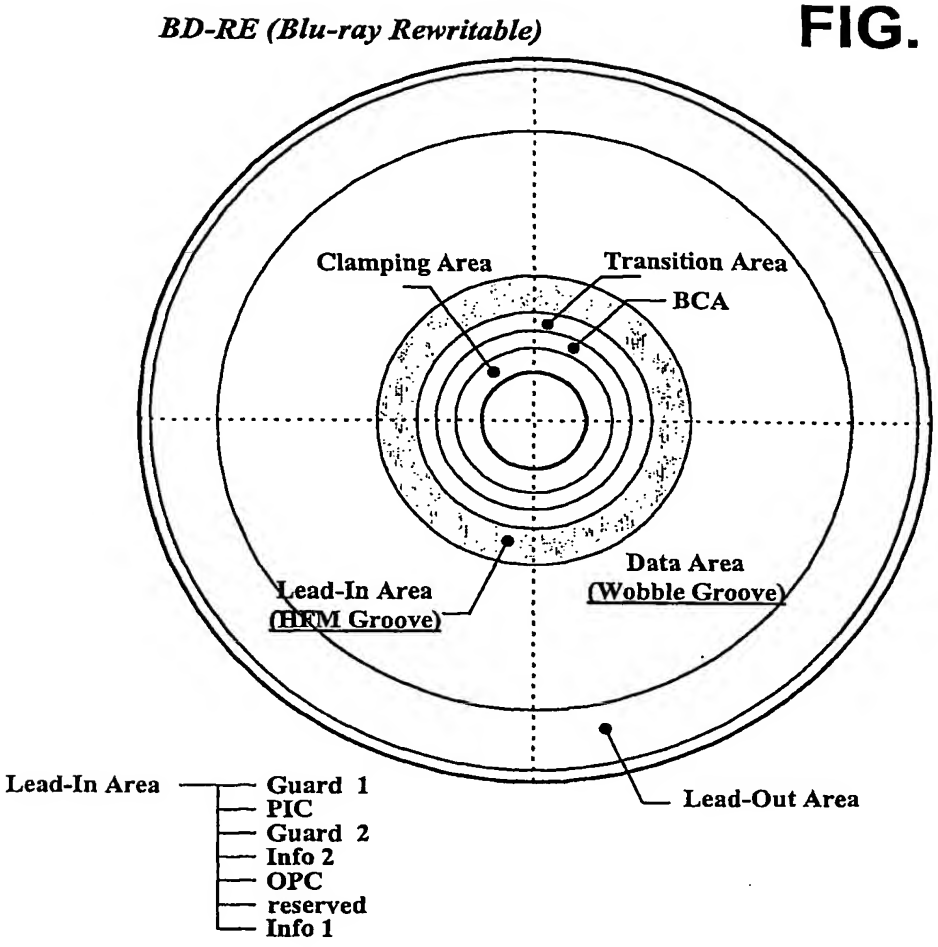

BD-RE (Blu-ray Rewritable)
Clamping Area
Transition Area
BCA
Lead-In Area
(HFM Groove)
Data Area
(Wobble Groove)
Lead-Out Area
Lead-In Area
Guard 1
PIC
Guard 2
Info 2
OPC
reserved
Info 1

FIG. 1B

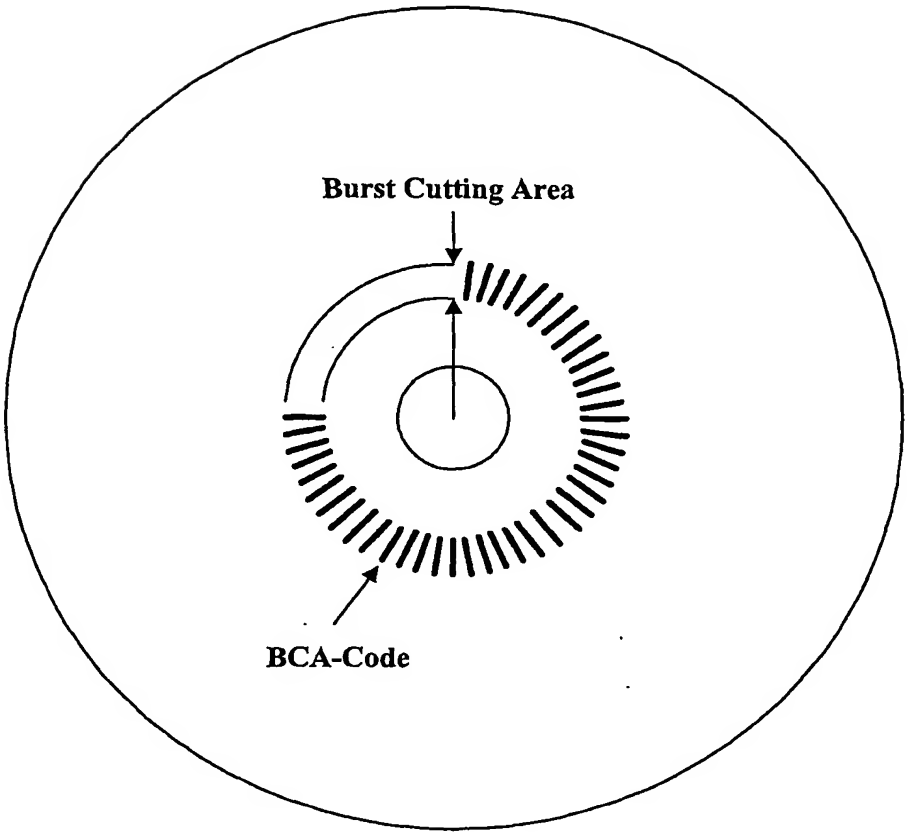
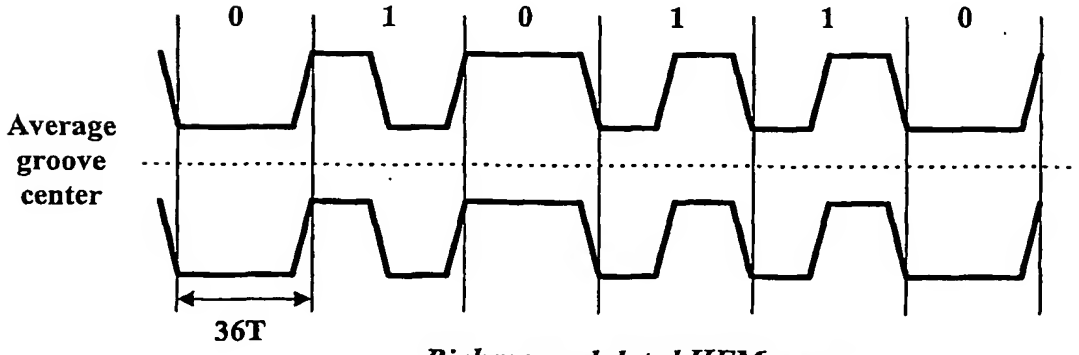


FIG. 2



Biphase modulated HFM groove

FIG. 3

BD-ROM (Blu-ray ROM)

<table>
<tr><td colspan="4">Inner area</td></tr>
<tr><td colspan="4">Clamping area</td></tr>
<tr><td colspan="4">Transition area</td></tr>
<tr><td rowspan="8">Information area</td><td colspan="3">BCA</td></tr>
<tr><td rowspan="7">Information zone</td><td rowspan="6">Lead-In zone</td><td>protection zone 1</td></tr>
<tr><td>PIC</td></tr>
<tr><td>protection zone 2</td></tr>
<tr><td>INFO 2</td></tr>
<tr><td>reserved</td></tr>
<tr><td>INFO 1</td></tr>
<tr><td colspan="2">Data zone</td></tr>
<tr><td rowspan="2">Lead-Out zone / Outer zone</td><td>INFO 3/4</td></tr>
<tr><td>protection zone 3</td></tr>
<tr><td colspan="4">Rim area</td></tr>
</table>

FIG. 4A

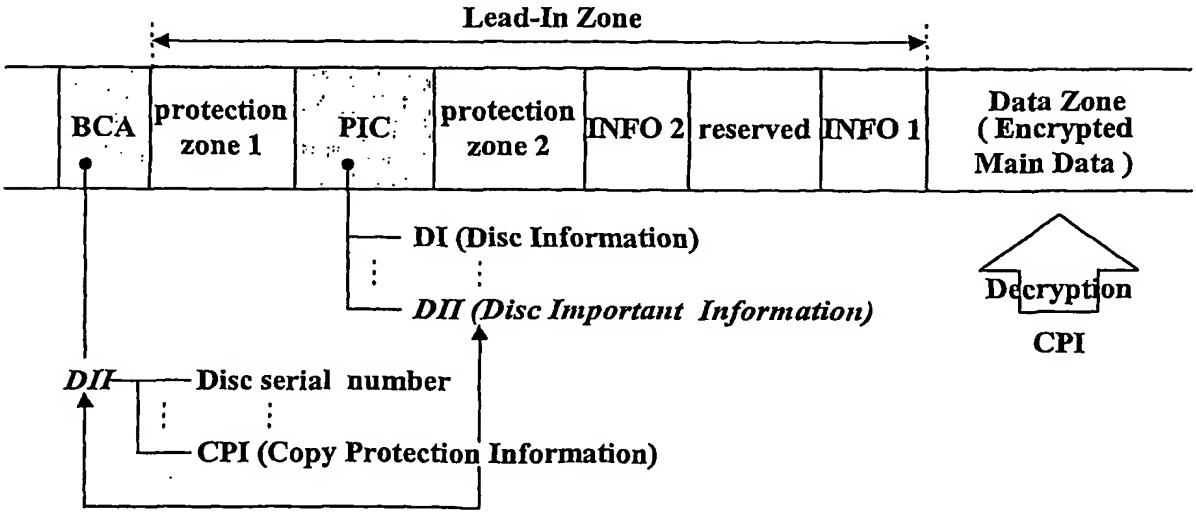


FIG. 4B

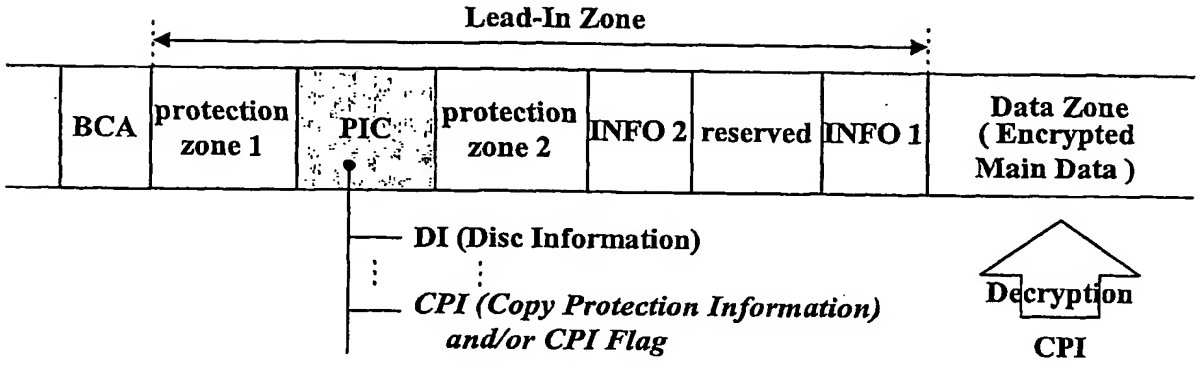

Lead-In Zone
BCA
protection zone 1
PIC
protection zone 2
INFO 2
reserved
INFO 1
Data Zone (Encrypted Main Data)
DI (Disc Information)
CPI (Copy Protection Information) and/or CPI Flag
Decryption
CPI

FIG. 4C

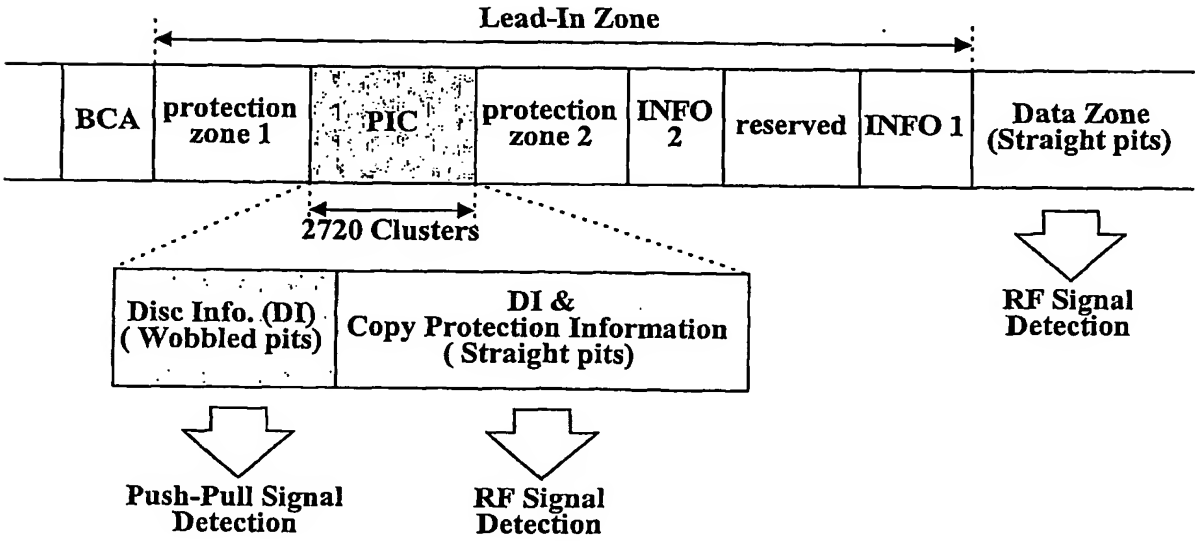

Lead-In Zone
BCA
protection zone 1
PIC
protection zone 2
INFO 2
reserved
INFO 1
Data Zone (Straight pits)
2720 Clusters
Disc Info. (DI) (Wobbled pits)
DI & Copy Protection Information (Straight pits)
RF Signal Detection
Push-Pull Signal Detection
RF Signal Detection

FIG. 4D

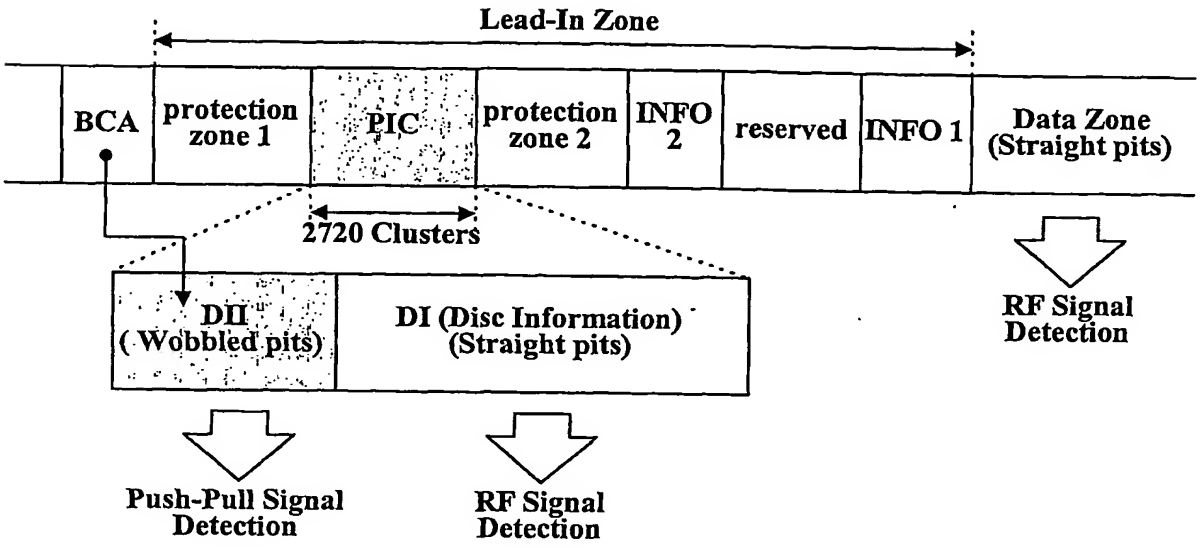

Lead-In Zone
BCA
protection zone 1
PIC
protection zone 2
INFO 2
reserved
INFO 1
Data Zone (Straight pits)
2720 Clusters
DII (Wobbled pits)
DI (Disc Information) (Straight pits)
RF Signal Detection
Push-Pull Signal Detection
RF Signal Detection

FIG. 4E

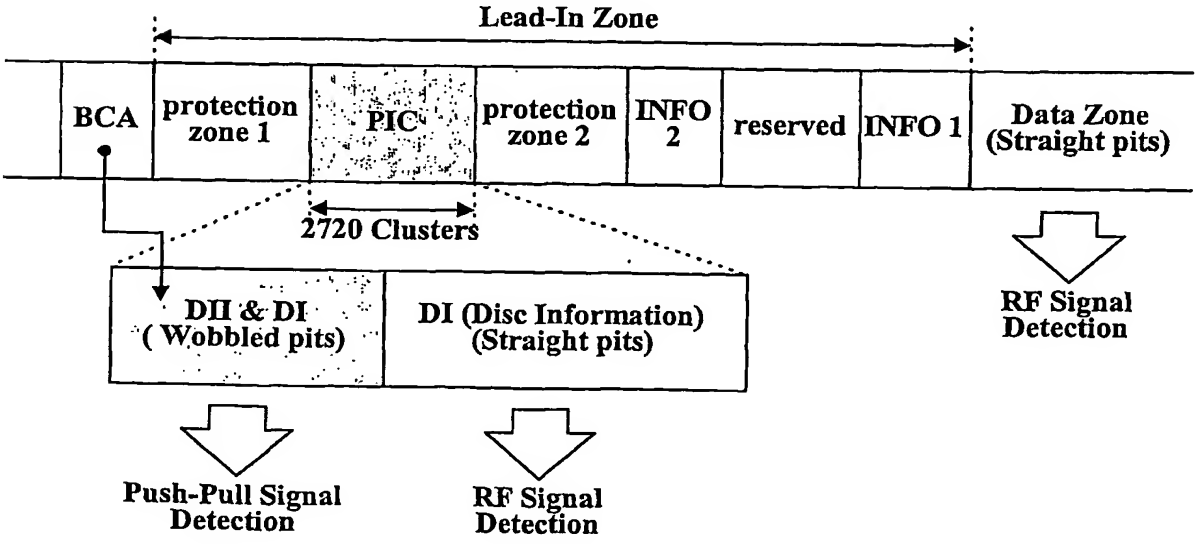

Lead-In Zone
BCA
protection zone 1
PIC
protection zone 2
INFO 2
reserved
INFO 1
Data Zone (Straight pits)
2720 Clusters
DII & DI (Wobbled pits)
DI (Disc Information) (Straight pits)
RF Signal Detection
Push-Pull Signal Detection
RF Signal Detection

FIG. 4F

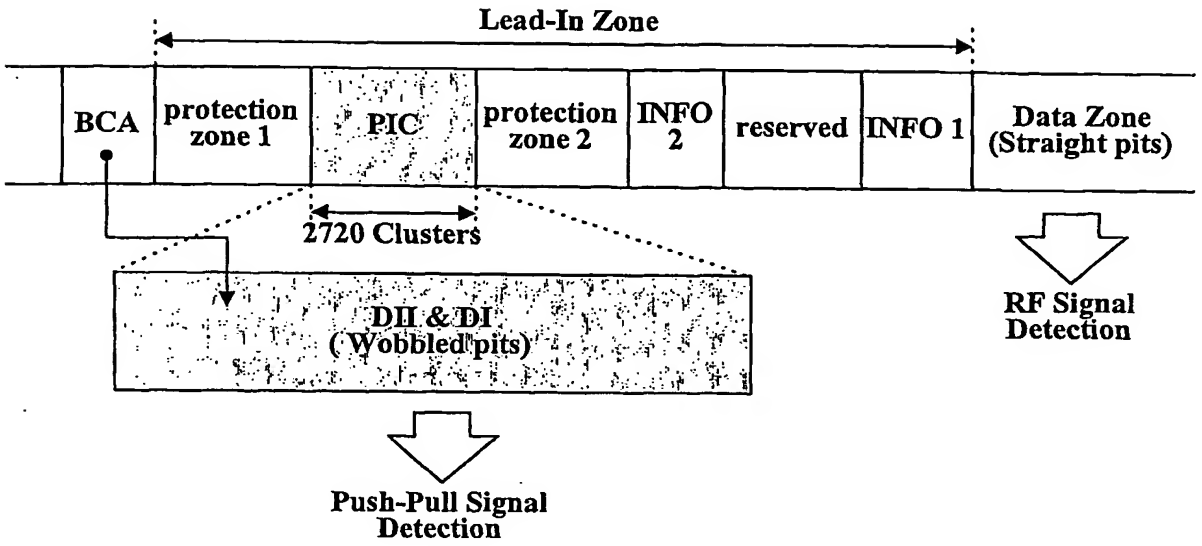

Lead-In Zone
BCA
protection zone 1
PIC
protection zone 2
INFO 2
reserved
INFO 1
Data Zone (Straight pits)
2720 Clusters
DII & DI (Wobbled pits)
RF Signal Detection
Push-Pull Signal Detection

FIG. 5

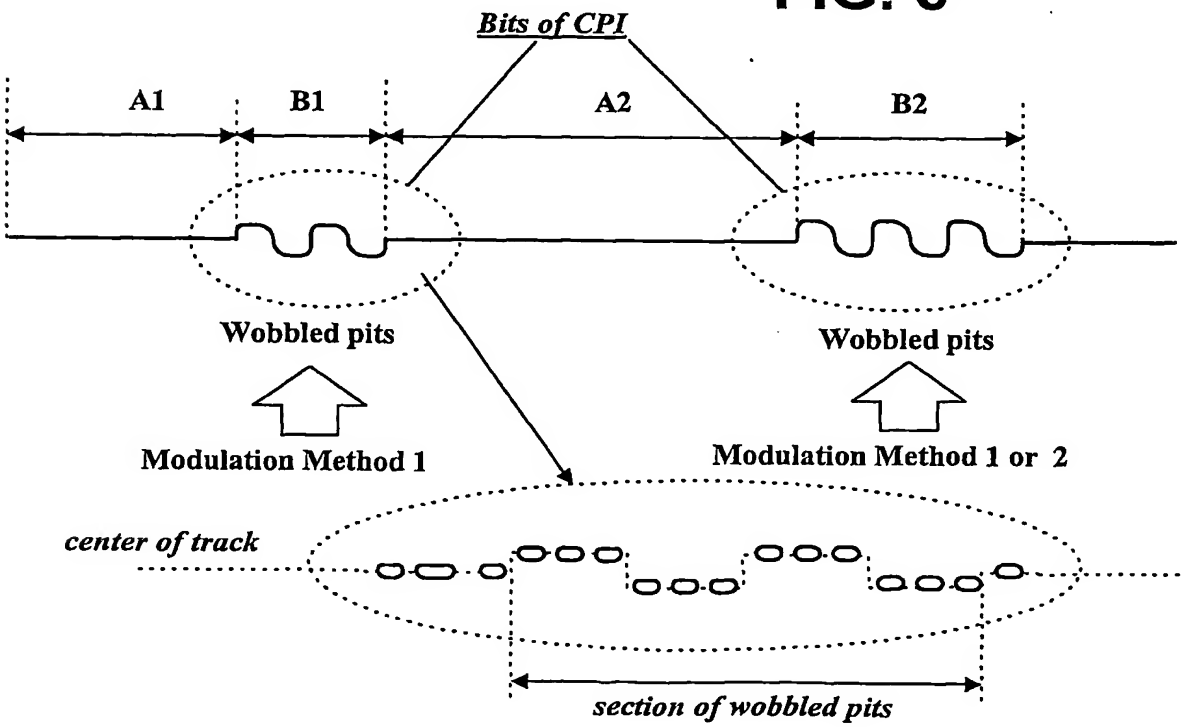

Bits of CPI
A1
B1
A2
B2
Wobbled pits
Wobbled pits
Modulation Method 1
Modulation Method 1 or 2
center of track
section of wobbled pits

FIG. 6

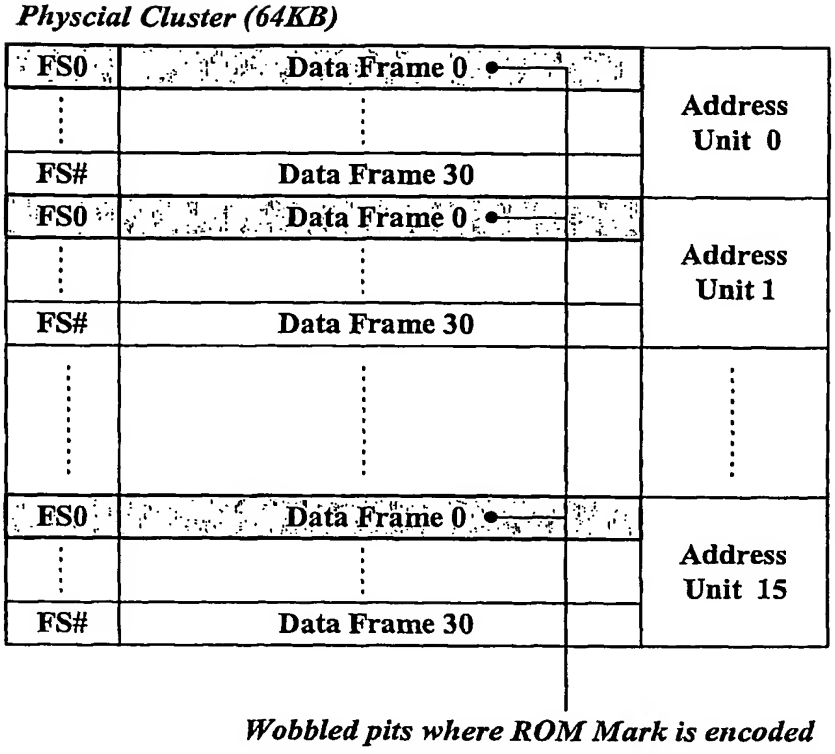

Physcial Cluster (64KB)
FS0
Data Frame 0
FS#
Data Frame 30
Address Unit 0
Address Unit 1
Address Unit 15
Wobbled pits where ROM Mark is encoded

FIG. 7

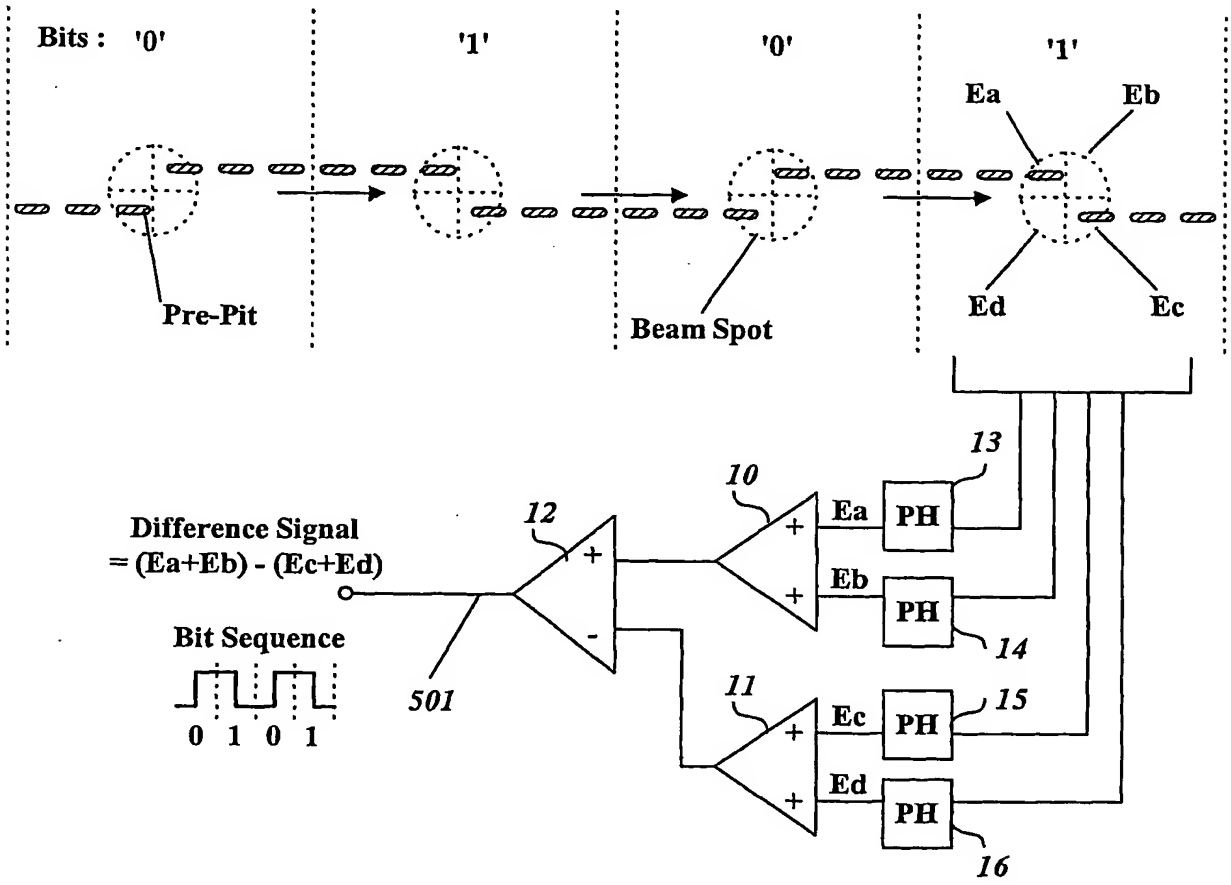

Disk Information encoded in Wobbled Pits by bi-phase Modulation
Bits : '0'
'1'
'0'
'1'
Ea
Eb
Ed
Ec
Pre-Pit
Beam Spot
Difference Signal
= (Ea+Eb) - (Ec+Ed)
Bit Sequence
0 1 0 1
501
12
10
11
13
14
15
16
PH

FIG. 8

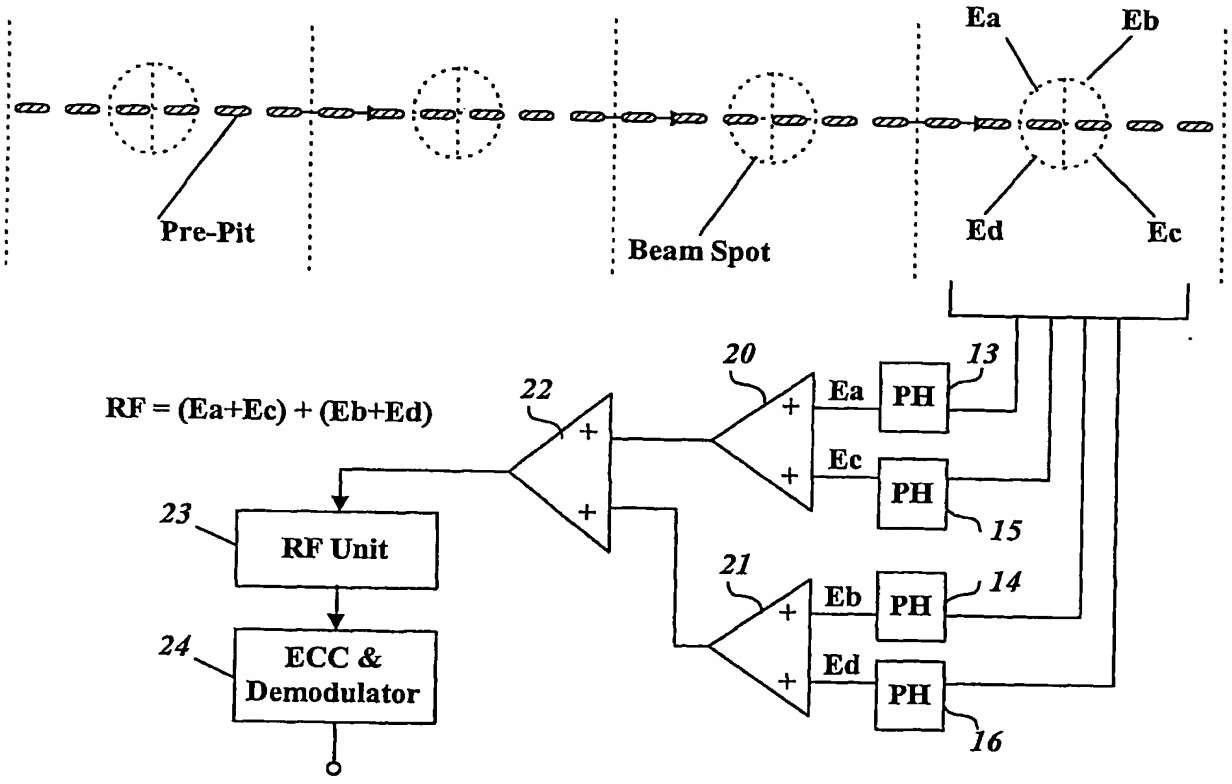

Disk Information written in straight pre-Pits
Ea
Eb
Pre-Pit
Beam Spot
Ed
Ec
RF = (Ea+Ec) + (Eb+Ed)
22
20
13
Ea
PH
Ec
PH
15
23
RF Unit
21
14
Eb
PH
24
ECC &
Demodulator
Ed
PH
16

FIG. 9

Byte number	Contents	number of bytes
0	Disc Information identifier = "DI"	2
2	DI format	1
3	Reserved = 00h	1
4	Number of DI frames in each DI Block	1
5	DI Frame sequence number in DI Block	1
6	Number of DI bytes in use in this DI Frame	1
7	Reserved = 00h	1
8 to 10	disc type identifier = "BDO"	3
11	disc size / version	1
12	disc structure	1
13	channel bit length	1
14 to 15	Reserved = all 00h	2
16	BCA descriptor	1
17	maxium transfer rate of application	1
18 to 23	Reserved = all 00h	6
24 to 31	Data zone allocation	8
32 to 111	Reserved = all 00h	13

FIG. 10

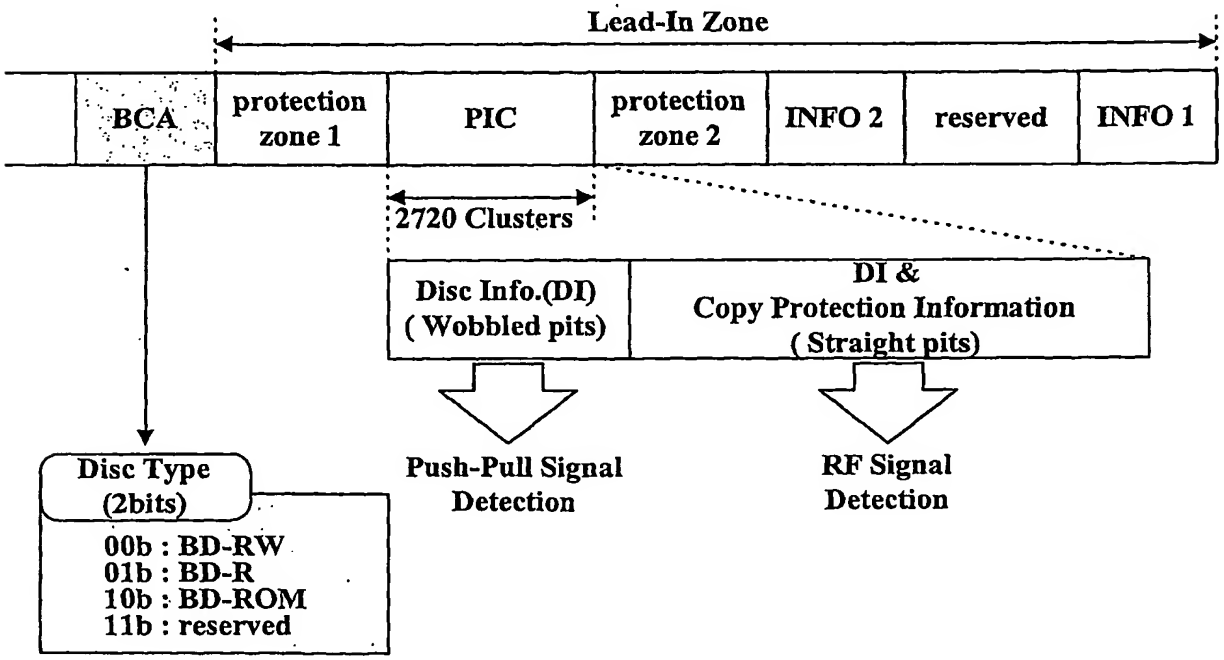
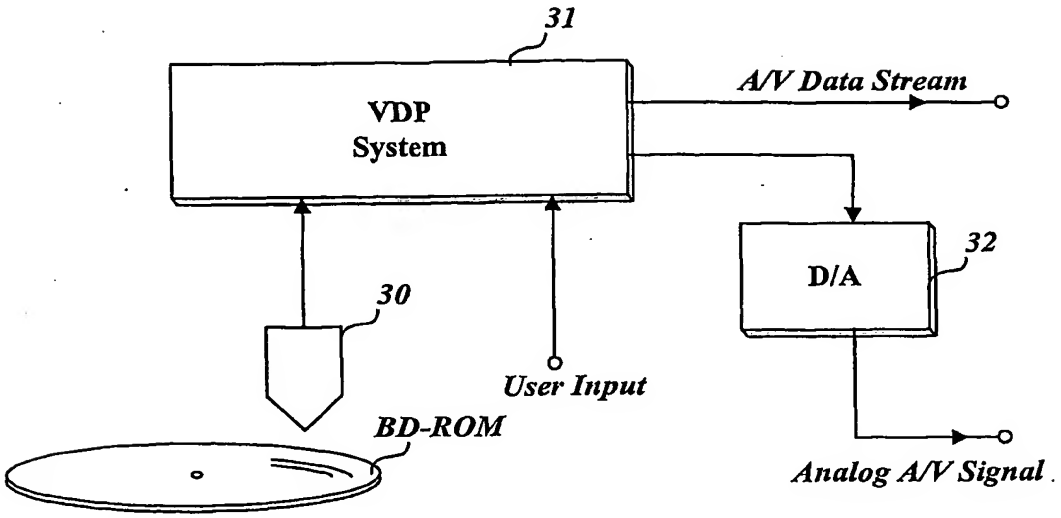


FIG. 11


31
VDP
System
A/V Data Stream
D/A
32
30
User Input
BD-ROM
Analog A/V Signal

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2004/000111

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G11B 7/007

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G11B 7/00-7/24, G11B20/00-20/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)
WPI,PAJ" WOBBLE","TRACK","PITS","COPY PROTECT*","LEAD-IN","BCA","PIC"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6289102 B1(MATSUSHITHA ELECTRIC INDUSTRIAL CO LTD.) 11 SEPT. 2001 See the whole document.	1
A	US 6031815 A(U.S. PHILIPSCORP.) 29 FEB. 2000 See the whole doccument.	1
A	US 2002-41686 A1(PIONEER CORPORATION) 11 APRIL 2002 See the whole document	1
A	US 6223285 B1(SONY CORP.OF JAPAN) 24 APRIL 2001 See the whole document	1
		1

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 MAY 2004 (17.05.2004)	18 MAY 2004 (18.05.2004)

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	SONG, Jin Suk Telephone No. 82-42-481-5694

Form PCT/ISA/210 (second sheet) (January 2004)

United States Patent [19]

Getreuer et al.

[11] **Patent Number: 4,879,707**

[45] **Date of Patent: Nov. 7, 1989**

[54] **OPTICAL DISK TRACKING AND SEEKING SYSTEMS SPECIFIC TRACK FORMATS USING DISCONTINUITIES**

[75] Inventors: **Kurt W. Getreuer**, Colorado Springs, Colo.; **Johannes J. Verboom**, Bergeijk, Netherlands; **Pierre R. Sonneville**, Weert, both of Netherlands

[73] Assignee: **Laser Magnetic Storage International Company**, Colorado Springs, Colo.

[21] Appl. No.: **148,028**

[22] Filed: **Jan. 25, 1988**

Related U.S. Application Data

[63] Continuation of Ser. No. 760,439, Jul. 30, 1985, abandoned.

[51] Int. Cl.[4] **G11B 7/09**; G11B 7/007

[52] U.S. Cl. **369/46**; 369/44; 369/105; 369/109; 369/124; 369/275

[58] Field of Search 369/44-46, 369/100, 105, 106, 109, 124, 275, 277; 358/342; 360/77, 77.01, 77.02, 77.03, 77.06, 77.07, 77.08, 77.11

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0099576	2/1984	European Pat. Off. .
8000122	1/1980	Netherlands .
2069219	8/1981	United Kingdom .

Primary Examiner—Alan Faber

Assistant Examiner—W. R. Young

Attorney, Agent, or Firm—Sheridan, Ross & McIntosh

[57] **ABSTRACT**

An optical disk recording system including a record medium is disclosed for providing an accurate track crossing count and an accurate track following signal. A first embodiment utilizes off-centered wobbled areas located in the headers of the record medium. The high frequency content of a first signal is combined with the low frequency content of a second signal, which is generated using the wobbled areas. In another embodiment, light-reflective discontinuities are provided in the header areas of the record medium. A qualifier and an AGC are utilized in providing a corrected track following signal. In still another embodiment, reflective discontinuities are located in the servo areas of the record medium. In such an embodiment, it is preferred that there be a fixed gain adjustment to a radial push-pull signal. With regard to each of the three aforesaid embodiments, a track following signal is corrected to compensate for aberrations that are caused by a shift of the light beam returned from the record medium surface. In yet another embodiment, the track following signal is generated using only the central aperture or wobble signal. In this embodiment, it is preferred that three pits be utilized in connection with the track following operation. The three pits are provided in two servo bytes of information located in the servo areas. Two of the three pits are wobble pits and the third pit is used in clocking.

7 Claims, 8 Drawing Sheets